REMARKS

This Application has been carefully reviewed in light of the Office Action mailed November 4, 2002. At the time of the Office Action, Claims 1-15 were pending in this patent application, of which Claims 11-15 were withdrawn from consideration. In the Office Action, Claims 1-10 were rejected. Applicants believe all previously pending claims are allowable over the prior art of record. However, to advance this case expeditiously to issuance, Claims 1 and 8 have been amended to clarify, more specifically point out, and more distinctly claim what the inventors believe to be the invention. Applicants cancel Claims 2, 9, and 11-15 without prejudice or disclaimer. These amendments are not considered necessary for patentability. Applicants respectfully requests reconsideration and favorable action in this case including an indication of the allowable nature of all pending claims.

Election/Restriction Requirement

In response to the Office Action mailed November 4, 2002, Applicants hereby affirm the election of Group I, Claims 1-10. This election is made without traverse. Applicants cancel Claims 11-15 without prejudice or disclaimer.

Objections to the Title

The Examiner objects to the title as being non-descriptive. Applicants have amended page 1 of the Specification and page 16 of the Abstract to correct the informalities identified by the Examiner.

Rejections under 35 U.S.C. § 103

The Examiner rejects Claims 1-10 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Publication 2001/0034088 to Nakamura, et al. (*Nakamura*), in view of U.S. Patent 4,908,334 to Zuhr, et al. (*Zuhr*). Applicants respectfully request reconsideration and allowance of Claims 1-10 for the following reasons.

Independent Claim 1 of the present Application, as amended, recites:

> A method of fabricating a semiconductor device including a crystallized active layer comprising the steps of:
> providing a substrate;
> depositing an amorphous silicon layer on said substrate;
> heating said substrate while depositing a metal layer to induce low temperature crystallization of amorphous silicon on at least a portion of said amorphous silicon layer, the metal layer comprising an element selected from the group consisting of nickel, palladium, tin, silver, gold, aluminum, copper, cobalt, chromium ruthenium, rhodium, cadmium, platinum, and antimony; and
> conducting a thermal treatment of said substrate so that said amorphous silicon layer is crystallized by metal induced crystallization propagating from the portion covered by said metal layer.

First, to defeat a patent under 35 U.S.C. § 103, "the prior art reference must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on Applicants' disclosure." *In re Vaeck*, 947 F.2d 488 (Fed. Cir. 1991); MPEP § 706.02(j). Applicants respectfully submit that the proposed *Nakamura-Zhur* combination does not disclose, teach, or suggest each and every limitation as recited in Applicants' Claim 1.

For example, neither *Nakamura* nor *Zhur* disclose, teach, or suggest "heating said substrate while depositing a metal layer to induce low temperature crystallization of amorphous silicon on at least a portion of said amorphous silicon layer," as recited in amended Claim 1. In fact, the Examiner acknowledges that *Nakamura* does not expressly disclose "heating the substrate while depositing a metal layer." (Office Action, page 4). Instead, the Examiner relies on *Zuhr* for disclosure of these features. *Zhur*, however, merely discloses the formation of metallic silicide films on the surface of heated silicon substrates by ion beam deposition "maintained at a relatively low energy level so as to inhibit losses by sputtering and to prevent the penetration of the ions into the substrate beyond a distance of only a few monolayers." (Column 2, lines 49-58). "The silicon substrate is heated during the contacting thereof with the metal ions to a temperature sufficient to effect diffusion of silicon atoms from the substrate to contact the metal ions as they are being deposited on the surface

of the substrate or any portion of the metallic silicide film subsequently formed thereon to essentially athermally interact therewith for continuously forming a film of stoichiometric m metallic silicide on the surface of the silicon substrate." (Column 2, lines 15-24). "Since the penetration depth of the ions into the substrate is small as required for a surface technique, then at the relatively low temperatures used herein, the reaction will stop after the silicide grows sufficiently thick (in the order of several monolayers) to isolate the silicon substrate from the newly arriving atoms." (Column 4, lines 4-10). Thus, the method for forming a metallic silicide film disclosed in *Zuhr* is limited to a method of manufacturing for diminishing the diffusion of ions into the substrate. Accordingly, *Zuhr* does not disclose, teach, or suggest "heating said substrate while depositing a metal layer to induce low temperature crystallization of amorphous silicon on at least a portion of said amorphous silicon layer," as recited in amended Claim 1.

Second, assuming for purposes of argument only that the proposed combination discloses the limitations of Claim 1, the Examiner has not cited language in either reference or within information commonly known to those skilled in the art that provides the necessary motivation or suggestion to combine these two references. Further, it would not have been obvious to one skilled in the art to make the combination. An important feature of the method of manufacturing disclosed in *Nakamura* includes "utilizing a crystalline semiconductor thin film containing silicon as the main component." (Page 1, paragraph 1). Thus, a metal is added to the surface of the semiconductor thin film and the structure is crystallized by the heat treatment with the metal as a catalyst. (Page 1, paragraphs 6-7). *Nakamura* further discloses that transition metal elements that used include nickel, cobalt, palladium, platinum, and copper and that nickel in particular "shows excellent property as the catalytic metal." (Page 1, paragraph 7). Accordingly, *Nakamura* may require using a catalytic metal. In contrast and as discussed above, *Zuhr* discloses a method for forming a metallic silicide by diminishing the diffusion of ions into the substrate. (Column 2, lines 48-59). Metals that "are slower diffusers or less mobile in metallic silicides than the silicon atoms" include "titanium, tungsten, iron, vandium, tantalum, and molybdenum." (Column 4, lines 37-46). By requiring metals that are slow diffusers, *Zuhr* actually teaches away from Applicants claimed invention. "A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. " *W.L. Gore &*

Assoc., Inc. v. Garlock, Inc., 721 F.2d 1540 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984); MPEP § 2141.02. For at least these reasons, one of ordinary skill in the art at the time of the invention would not have been motivated to combine the method for forming a crystalline semiconductor film with a metal catalyst disclosed in *Nakamura* with the method for slowing diffusion of metal ions disclosed in *Zuhr*.

The mere fact that references can be combined does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680 (Fed. Cir. 1990). The Examiner speculates "it would have been obvious" to make the proposed combination to provide "the silicon atoms necessary for forming the stoichiometric metallic silicide." (Office Action, page 4). On the contrary, a modification of *Nakamura* to include the features of *Zuhr*, as proposed by the Examiner, would impermissibly change the principle of operation disclosed in *Nakamura*. As discussed above, the objective of the method disclosed in *Nakamura* is to crystallize the semiconductor thin film to form an amorphous structure containing as a main component a silicon, which requires using a catalytic metal during heat treatment of the semiconductor device. (Page 1, paragraphs 6-7). If a "proposed modification would render the prior invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification." MPEP § 2143.01. Also, if a "proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." MPEP § 2143.01. Accordingly, Applicants respectfully submit that it would not have been obvious to one of ordinary skill in the art at the time of invention to combine the formation of the catalytic metal layer disclosed in *Nakamura* with the method for slowing the diffusion of metal ions disclosed in *Zuhr*.

For at least these reasons, Applicants respectfully request reconsideration and allowance of Claim 1, together with Claims 2-10 that depend from Claim 1.

Dependent Claims 2-10 that depend on independent Claim 1 are not obvious over *Nakamura* and *Zuhr* for the following reasons. First, Claims 2-10 include the limitations of Claim 1, which Applicants have shown above to be allowable. Second, dependent Claims 2-

10 add additional elements that further distinguish the art. As just one example, Claim 3 recites that "the substrate is heated at a temperature in a range of 200-700° C." In the Examiner's rejection of the claim, the Examiner acknowledges that *Nakamura* does not teach heating the substrate while depositing a metal layer. (Office Action, page 4). Rather, the Examiner relies on *Zuhr* for disclosure of these features. *Zuhr*, however, discloses that "[i]t has been found that for the formation of stoichiometric metallic silicide films with a thickness in the aforementioned range [1 to 300 nm] that heating the silicon substrate to the temperature in the range of about 400° to 600° C is required." (Column 4, lines 17-21). Heating the temperature less then about 400° C provides "an insufficient concentration of silicon atoms to produce a uniformly stoichiometric silicide throughout the film thickness. Also with temperatures greater than about 600° C no beneficial increase in the diffusion of silicon atoms is realized and deleterious diffusion and/or volatization of the dopants from the substrate starts to occur and increases with increasing temperature." (Column 4, lines 21-30). Thus, *Zuhr* specifically teaches away from heating the substrate to "a temperature in a range of 200-700° C," as recited in dependent Claim 3. Third, for reasons discussed above with regard to Claim 1, Applicants submit that one of ordinary skill in the art at the time of the invention would not have been motivated to make the proposed *Nakamura-Zuhr* combination. To the contrary, a modification of *Nakamura* to include the features of *Zuhr*, as proposed by the Examiner, would impermissibly change the principle of operation disclosed in *Nakamura*.

For at least these reasons, Applicants respectfully request reconsideration and allowance of Claims 2-10.

CONCLUSION

Applicants have made an earnest attempt to place this case in condition for allowance. For the foregoing reasons, and for other reasons clearly apparent, Applicants respectfully request full allowance of all pending claims.

If there are any matters which can be discussed by telephone to further the prosecution of this Application, Applicants invite the Examiner to call the undersigned attorney at the number below at the Examiner's convenience.

Although no fees are believed due, the Commissioner is hereby authorized to charge any fees or credit any overpayment to Deposit Account No. 02-0384 of Baker Botts L.L.P.

Respectfully submitted,

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MARKED UP VERSION OF SPECIFICATION AND CLAIM AMENDMENTS

For the convenience of the Examiner, all claims have been presented whether or not an amendment has been made. The Specification and Claims are amended as follows:

In the Specification

Please amend the Specification by replacing the title with the following:

METHOD **[AND APPARATUS FOR]** OF FABRICATING A SEMICONDUCTOR DEVICE **INCLUDING A CRYSTALLINE ACTIVE SILICON LAYER**

In the Abstract

Please amend the Abstract by replacing the title with the following:

METHOD **[AND APPARATUS FOR]** OF FABRICATING A SEMICONDUCTOR DEVICE **INCLUDING A CRYSTALLINE ACTIVE SILICON LAYER**

In the Claims

1. **(Amended)** A method of fabricating a semiconductor device including a crystallized active layer comprising the steps of:

providing a substrate;

depositing an amorphous silicon layer on said substrate; **[and]**

heating said substrate while depositing a metal layer **[inducing]** **to induce** low temperature crystallization of amorphous silicon on at least a portion of said amorphous silicon layer**, the metal layer comprising an element selected from the group consisting of nickel, palladium, tin, silver, gold, aluminum, copper, cobalt, chromium ruthenium, rhodium, cadmium, platinum, and antimony; and**

conducting a thermal treatment of said substrate so that said amorphous silicon layer is crystallized by metal induced crystallization propagating from the portion covered by said metal layer.

Please cancel Claim 2 without prejudice or disclaimer.

3. The method according to Claim 1, wherein the substrate is heated at a temperature in a range of 200-700°C.

4. The method according to Claim 1, wherein said metal layer is deposited using at least one of sputtering, heating evaporation, PECVD and CVD.

5. The method according to Claim 1, wherein the substrate is heated by using a heat conduction or a heat radiation method.

6. The method according to Claim 1, wherein a portion of said metal layer contacting with said amorphous silicon layer forms a metal silicide.

7. The method according to Claim 6, wherein other portions of said metal layer remain in the state of metal and further comprising a step of removing the remaining metal layer by etching.

8. **(Amended)** The method according to Claim 1, wherein at least a portion of said amorphous silicon layer is crystallized by **[MIC]** **metal induced lateral crystallization** during the process of heating the substrate while depositing the metal layer.

Please cancel Claim 9 with prejudice or disclaimer.

10. The method according to Claim 1, wherein the step of heating the substrate while depositing the metal layer comprises the steps of:

forming an insulation layer on said substrate and said amorphous silicon layer;

removing a portion of said insulation layer to expose a portion of said amorphous silicon layer; and

depositing said metal layer on the exposed surface of said amorphous silicon layer while heating said substrate.

Please cancel Claims 11-15 without prejudice or disclaimer.